INDEX SELECTION ENGINE FOR SPATIAL DATABASE SYSTEM

MARUTO MASSERIE SARDADI

UNIVERSITI TEKNOLOGI MALAYSIA

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MARUTO MASSERIE SARDADI

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To my God, Allah 'azza wa jalla

and

Dedicated to my mother and father whose love, encouragement and values will always guide and inspire me.

Idawati

Baskoro Sardadi

and

To my brother, Baruno Sardadi and my wife, Maulidya Maherany

In the hope that they will be encouraged to strive for the best and thank you so much for being so patient and being there for me.

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ABSTRACT

The latest mobile Geographical Information System (GIS) technology is useful to manage spatial components of various daily business projects in corporate databases. It is important to apply proper geographical analysis efficiently in a wireless application. However, one of the problems of wireless internet is system bottlenecks that can slow down data processing in Mobile GIS. Spatial data indexing is one of the methods to speed up spatial queries. The existing spatial data indexing can only change the index used. However, an indexing method is only better for some ranges of data and conditions. The objective of this research is to speed up access to spatial database system by using spatial index selection engine. This research introduces an index selection engine for spatial database system for every condition and range of data, on top of the basic index structure. The index selection engine, which is called QuadRtree Selection engine, uses a rule-based Knowledge Base Expert System (KBES) to select between R-tree and Quadtree spatial data indices. These spatial data indexing methods are the best spatial data indexing methods among many other existing spatial index methods for low-dimensional spatial data which have different advantages and disadvantages based on the condition of spatial data. The result of using the proposed method can save time up to 42.5% compared to not using this method.

ABSTRAK

Teknologi Sistem Maklumat Geografi (GIS) mudah alih terkini berguna untuk mengurus komponen ruang dalam pelbagai urusan harian projek perniagaan pada pangkalan data koprat. Teknologi ini penting untuk penggunaan analisa geografi secara efisen dalam aplikasi tanpa wayar. Namun, teknologi tanpa wayar ini boleh melambatkan proses pemindahan data akibat daripada kesesakan laluan sistem di dalam teknologi GIS mudah alih. Mengindeks data ruang merupakan salah satu kaedah untuk mempercepatkan pertanyaan berasaskan ruang. Kaedah peningkatan mengindeks data ruang yang sedia ada hanya boleh mengubah indeks yang digunakan. Namun, kaedah mengindeks hanya lebih baik untuk beberapa julat data dan keadaan. Objektif penyelidikan ini adalah untuk mempercepatkan capaian pada sistem pangkalan data ruang dengan menggunakan mesin pemilihan indeks ruang. Penyelidikan ini memperkenalkan mesin pemilihan indeks untuk sistem pangkalan data ruang dalam setiap keadaan dan pelbagai julat data, ke atas struktur asas indeks. Mesin pemilihan indeks ini, yang disebut mesin pemilihan QuadRtree, menggunakan Pangkalan Pengetahuan Sistem Pakar berasaskan peraturan untuk memilih antara indeks data ruang R-tree dan Quadtree. Kaedah mengindeks data ruang ini adalah kaedah mengindeks data ruang yang terbaik di antara banyak kaedah pengindeks data ruang yang sedia ada untuk data yang berdimensi rendah di mana mempunyai perbezaan kelebihan dan kekurangan berdasarkan keadaan data ruang. Keputusan menggunakan kaedah yang dicadangkan boleh menjimatkan masa sehingga 42.5% dibandingkan dengan tidak menggunakan kaedah ini.

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LIST OF ABBREVIATIONS

4CRS	Four-Color Raster Signature
AI	Artificial Intelligence
AIDS	Acquired Immunodeficiency Syndrome
AJAX	Asynchronous JavaScript Technology and XML
API	Application Programming Interface
AS	Application Server
CBIR	Content-Based Image Retrieval
CDMA	Code Division Multiple Access
CCAA	Computable Context-Awareness Approach
CISMeF	Catalogue and Index of French-speaking Medical Sites
DML	Data Manipulation Language
DW	Data Warehouse
FSI	Fluid-Structure Interaction
GABRIEL	Gis Activity-Based Travel Simulator
GIS	Geographic Information System
GKD	Geographic Knowledge Discovery
GPS	Global Positioning System
GSM	Global System for Mobile communication
HIV	Human Immunodeficiency Virus
HMBR	Hybrid Minimum Bounding Rectangle
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
I/O	Input / Output

IG	Information Gain
IIS	Internet Information Services
IR	Information Retrieval
ITS	Intelligent Transformation System
JDBC	Java Database Connectivity
KBES	Knowledge Based Expert System
KML	Keyhole Markup Language
KMS	Knowledge Management Systems
LBS	Location Based Service
LOD	Level of Detail
LRS	Linear Referencing System)
MBR	Minimum Bounding Rectangle
MHF	Multilevel Hashing File
MPI	Message Passing Interface
MoGeo	Mobile Geographic Education
MVLQ	Multiversion Linear Quadtree
NSERC	Natural Sciences and Engineering Research Council
OLAP	On-Line Analytical Processing
OPMN	Oracle Process Manager and Notification Server
p-FEM	Spectral Finite Element
PC	Personal Computer
PDA	Personal Digital Assistants
PIST	Practical Index for Spatio-Temporal
POS	Part-of-Speech
PL/SQL	Procedural Language/Structured Query Language
RDBMS	Relational Database Management System
SDBMS	Spatial Data Base Management System
SISCam	Seismotectonic Information System of the Campania Region
SNDB	Simple Network Database
SOA	Service-Oriented Architecture
SOLAP	Spatial On-Line Analytical Processing
SP	Search Profile
SSL	Secure Socket Layer

SQL	Structured Query Language
STAMs	Spatio-Temporal Access Methods
TCP	Transmission Control Protocol
URL	Uniform Resource Locator
UTM	University Technologi Malaysia
WiFi	Wireless Fidelity
WiMax	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area Network
WPAN	Wireless Personal Area Network
WWAN	Wireless Wide Area Network
WWW	World Wide Web
XML	Extensible Markup Language

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Mobile GIS can be described as an extension of a Geographical Information System (GIS). Previously, GIS can only run in an office with a desktop GIS. By using mobile GIS, user can retrieve, transfer, update, manipulate, analyze and display geographic information anywhere and anytime. The standard technology integrated in Mobile GIS application are wireless network for internet transfer and data access, mobile device to run GIS application everywhere and Global Positioning System (GPS) to detect the location.

Over the last few years, Mobile GIS applications and technological trends have a rapid development. The success and emergence of the WWW (World Wide Web) and internet also support its rapid advancement. Geo-information technology has emerged from mainframe computers to stand alone desktop computer GIS, local networking GIS, web GIS and the latest is Mobile GIS where map and information are run and displayed on small mobile devices such as Mobile Phones and Personal Digital Assistants (PDA) (Rajinder, 2004).

Internet as telecommunication network over the world can be used for transferring geographical data. The integration of the internet and GIS technologies also known as internet GIS can support the demand for geographical data access and transfer (Peng & Tsou, 2003). Additionally, internet can be used for communication data between client and server. By using Mobile GIS, field data collection can be settled and sent to the server for further processing and those processes are simpler. Furthermore, client can access the information needed to enhance the collection of geographical data.

Rapid improvement in the Mobile GIS technology can solve mobile application device problems such as its small bandwidth, limitation of application capability, color resolution and small screen display (Vckovski, 1999). Recent developments of internet and Mobile GIS technology enable process of spatial data transferring, collection, processing and dissemination with large amount of geographical data (Kraak, 2002).

Indexing is one of database optimization processes which can be created using one or more database table columns to provide the foundation of rapid searching and efficient access of ordered records. Spatial indexing has a great methodology for managing records and it is identified based on its organization with a place. Some of the records are strongly connected to a place. Like other structures of indexing, geographical indexing may be merged with other indices. The difference is that spatial index has particular access process to retrieve spatial data from within the data-store and to optimize spatial queries by spatial databases.

This research attempts to provide a suitable spatial data indexing method which can reduce time of spatial data processing in Mobile GIS technology, and it attempts to provide a tuning method for spatial data indexing. The last stage is developing a web based application that can run in any Mobile GIS application to show a map. This research will be helpful in all areas that use mobile GIS applications to make decisions in the field.

1.2 Problem Background

Previously, data collection and editing process in the field take a lot of time and the result is susceptible to some errors. GIS users must visit the field to take the geographical data in the structure of paper maps. Then they carry out field edit using draft and notes on paper maps and structure. After getting geographical data, processing of field edits in the office must be interpreted and manually entered into spatial database. Consequently, geographical data is rarely accurate and up-to-date as it could have been.

With the rapid developments on Mobile GIS, now GIS can be practically used in some devices such as compact digital maps, laptop (mobile computer), PDA, etc. This new GIS technology enables companies or GIS users to get real time geographical information, much faster data update to database and application, efficient analysis, geographical data display and simpler decision making in the field.

This research deals with the development in Mobile GIS technology. In the database main area of Mobile GIS technology, the majority of latest issues and problems come from network, access, system and application, and design. In the network area there are many issues and problems on network transportation (Kwan & Casas, 2006), and bandwidth of the network transmission (Qin & Li, 2006). In the access area, the issues and problems usually come from limited computer access (Hinze et al., 2006), sensor on the information (Malek et al., 2007), query and target objects (Feng et al., 2007), and location service (Timpf, 2006). For system and application area, the issues and problems usually came from GIScience (Mount et al., 2007), Location Based Service (LBS) (Ahas et al., 2007; Min et al., 2006), map (Sarjakoski, 2007; Mwambi & Zuma, 2007), mobile devices (Cao et al., 2007), Intelligent Transformation System (ITS) (Lu, 2006), web application (Cao et al., 2007), and water management (Minor et al., 2007). Finally, in the design area, the issues and problems usually came from kinetic data structures (Blunck et al., 2006), design management (Nappi et al., 2007), large volume of geo-based model and multi-stage graphic pipeline (Coors et al., 1999; Losa & Cervella, 1999), algorithm design (Karnatak et al., 2007), and traditional techniques design (Burigat & Chittaro, 2007).

Nowadays the use of internet increases significantly. It makes internet system management more complicated and difficult. Currently, most of the actions lead to increase the mobile service presented by the internet. However, this approach produces many network problems. Previously, many improvements are increasing the storage on the web server through spreading out of the communication bandwidth. Nevertheless, this former improvement takes very high cost and the bandwidth development is not appropriate in a mobile environment.

The major concern of most wireless technology is the overloading of servers because of system bottleneck phenomenon. Mobile GIS applications use wireless technology for transferring process and retrieving data, besides needs concentrating to explore and solve that problem. There are four main areas affecting system bottleneck phenomenon; database, network, application server and web server. The major problem for system bottleneck phenomenon originates from the database (Kwan & Shi, 2002). Infrastructure and architecture exploration are the main part in mobile computing research to solve system bottleneck problem. This has been done by developing the third generation mobile systems or resolving cache management of the database. Thus optimizing the existing system such as fine tuning database is an important step to enhance the overall performance.

Database research can be grouped into two major areas, they are database design and database access. In the design database there are many issues and problems with modeling spatio-temporal database area (Praing & Schneider, 2007), information and operating database area (Kim et al., 2006), geo ontologies in geo databases area (Baglioni et al., 2007), and spatial-network constrained moving objects area (Lu et al., 2007). In another area, which is in the access database there are many issues and problems in the access control in geographic databases area (Sasaoka & Medeiros, 2006), access control in the mobile crisis management systems area (Luyten, 2006), Data Warehouse (DW) and On-Line Analytical Processing (OLAP) area (Rivest et al., 2001), spatial data sharing, data warehousing and database federation area (Yeung & Hall, 2007), spatial database systems area (Yeung & Hall, 2007), SOLAP (Spatial OLAP) area (Bédard et al., 2007), spatial network databases area (Chang et al., 2006), spatial-temporal databases area (Azevedo, 2007), spatial database cluster and storage area (You et al., 2007), indexing technique for historical Spatio-Temporal point data area (Botea et al., 2007), spatial index and hashing technique area (Kim et al., 2005).

Data model separation for future movements is one of the problems in spatio-temporal database modeling area. The problems are the lack of generic data model for future movements also separation of past and future movement models for moving objects. These problems have been solved using design of spatio-temporal predicates on Balloon objects. Balloon objects is the model which considers both the past and the future movements of moving objects while preserving their temporal consistency. It based on a new set of spatio-temporal data types and operations which considers both past and future movements of moving objects while preserving their temporal consistency approaches. This subject area has some issues for further research by considering chances quantification in which relationship between balloon objects which is composed of sequence of certain and uncertain relationship between its parts can occur (Praing & Schneider, 2007).

Quantity and quality data limitation in highway database is a problem in information and operating database area. Highways are constructed and managed by various authorities. The facilities along it have individual specifications. Therefore, obtaining detail information about the facilities and equality of format information is crucial in operating databases of highways and their facilities. This problem has been solved using mobile mapping system approach for fast and economic acquisition of qualitative information of highways and its facilities. However, this subject still has some issues for further research which is obtaining detail information about the facilities. Besides, equality of information format is critical issue in operating databases of highways and their facilities (Kim et al., 2006).

There are some geo ontologial problems in geo databases area, i.e. complexity, high cost and time consuming task. Those problems can lead to mistakes and information missing to construct ontology which can be constructed manually from data analysis of database structure and table contents. But those problems can be answered by describing an approach to extract geospatial ontology from geographical data stored in spatial databases. Indeed, this subject needs further research to investigate how to exploit the enriched ontology for semantic integration of geo databases (Baglioni et al., 2007).

Range monitoring of mobile object in network distance appears as problem in spatial-network constrained moving objects area. Furthermore, the ability to continuously monitor mobile objects position is important in many applications. This problem has been solved by proposing an architecture where mobile clients and central server can share computation to obtain scalability by utilizing the capabilities of the clients. The proposed method can improve query maintenance and synchronization by recognizing the overlapping queries. Further research that concern on spatial-network constrained moving objects, monitoring free-moving objects is still needed in this area (Lu et al., 2007).

Determining when users or applications can access stored data and what kind of access they are allowed are some of the problems in the access control on geographic databases area. Verifying the type of store access data for applications and users is one of the problems in access control database. This problem has been solved with extending classical models and mechanisms to the spatial context. Indeed, this subject area still has some issues for further research that need to concerns the incorporation of nested permissions, conflicts among their rules to maintain rule consistency, and the performance concerns impact of checking algorithms (Sasaoka & Medeiros, 2006).

A firefighter emergency mission is very important to get the trustworthy overview of each member in fire brigade complete situation. Those are some of the problems in the mobile crisis management systems area. This problem has been solved with reporting the design and development of a system to support a fire brigade on site with a set of mobile services that offers a role-based focus + context user interface. Further research that need to add context-awareness without changing the structure or navigation of the user interface, but merely parts of the presentation is still needed in this area (Luyten, 2006).

The system that can't store and manipulate data is one of the problems in the Data Warehouse (DW) and On-Line Analytical Processing (OLAP) area. Since it is estimated that about 80% of data stored in databases has a spatial or location component (Rivest et al., 2001), location dimensions have been widely integrated in DWs and in OLAP systems. This problem has been solved by proposing the transformation of a conceptual schema based on the MultiDimER constructs to an object-relational schema. They based our mapping on the SQL: 2003 and SQL/MM standards giving examples of commercial implementation using Oracle 10g with its spatial extension. However, this subject area still has some issues for further research that the additional programming effort is required to ensure the equivalence between conceptual and logical schemas (Malinowski & Zimányi, 2006).

Spatial data sharing is one of the problems in the spatial data sharing, data warehousing and database federation area. Spatial data sharing is no longer perceived simply as the selling of maps or the occasional exchange of data among individuals or organizations. Instead, it has become both a commercial business and a standard practice in modern data processing that transcends different application and technical domains. This problem has been solved using approaches in semantic modeling within the many database communities that exist even within the global spatial data domain. Indeed, this subject area still has some issues for further research, as the increasing use of standards has gradually eliminated many of the difficulties resulting from incompatibility of data structure and syntax, spatial data sharing at present is predominantly concerned with issues of access (including policy, legal liability, discovery and dissemination) and collaborated applications (semantics and interfaces), rather than with the technical exchange of data between disparate data sets as in the past (Yeung & Hall, 2007).

How to support basic needs in spatial data capture, provide easily understandable spatial data structures models, and facilitate cartographic presentation are some of the problems in the spatial database systems area. Conventionally, the spatial information industry sought to support basic needs in spatial data capture, provide easily understandable spatial data structures and models, and facilitate cartographic presentation of the results of spatial analysis and map-based manipulation of data. This problem has been solved with identifies the major current trends in spatial design database and implementation, review emerging concepts and techniques that are shaping the trends of spatial database systems from the perspectives of technology, data, application and people, and discusses the implications of these trends for the spatial database research community. Indeed, this subject area still has some issues for further research. Building spatial data and a data-centric environment that places emphasis on the need to understand spatial databases and their management rather than focus on technical aspects of the spatial data themselves will characterize the future spatial information industry (Yeung & Hall, 2007).

Slow down query and cryptic data structures are some of the problems in the SOLAP (Spatial OLAP) main subject. Geographic Knowledge Discovery (GKD) requires systems that support interactive exploration of data without being slowed down by the intricacies of a SQL (Structured Query Language) type query language and cryptic data structures. This problem has been solved using a Hypermedia SOLAP method. GKD requires comparing maps of different phenomena or epochs, to dig into these maps to obtain detailed information, to roll-up data for more global information and to synchronize maps with tables and charts. However, this subject area still has some issues for further research. While such developments will enhance the experience of the user with the system, important questions remain with respect to the competing objectives of providing documents to fulfill the requirements of specific users and concomitantly respecting privacy concerns. Future works related to the NSERC (Natural Sciences and Engineering Research Council) Industrial Research Chair will take such considerations into account and will address some technological and legal issues raised by the distribution and the sharing of such Hypermedia and SOLAP information over networks. As it has designed and developed the SOLAP technology used for the project (Kheops, 2005). It will continue improving this technology, including its enrichment with other types of data such as hypermedia (Bédard et al., 2007).

Spatial network databases that consider Euclidean spaces in spatial databases, where the distance between two objects is determined by the ideal shortest path connecting them are some of the problems in the spatial network database area. Most of existing work in spatial databases considers Euclidean spaces, where the distance between two objects is determined by the ideal shortest path connecting them (Shekhar et al., 1999). This problem has been solved with designed the architecture of disk-based data structures for SNDB (Simple Network Database. Further research that required to study on e-distance join and closest-pairs query processing algorithms for SNDB based on their range and k-NN query processing algorithms is still needed in this area (Chang et al., 2006).

How to process queries efficiently so that the user does not have to wait a long time to get an answer is one of the problems in the spatial-temporal databases main subject. This problem has been solved using raster signatures method, approximate the query processing in spatial databases. They extended the proposals of using Four-Color Raster Signature (4CRS) (Zimbrao & Souza, 1998) for fast and approximate processing of queries over polygon datasets. Indeed, this subject area still has some issues for further research. Providing a short time answer to queries becomes a bigger challenge in spatial database area, where the data usually have high complexity and are available in huge amounts (Azevedo, 2007).

Huge amount of data in sensor networks that is collected by millions of sensors and small mobile devices need to be processed fast. In addition, the database requires to always acting in response. This is one of the problems in spatial database cluster and storage area. This problem has been solved using the cluster recovery of spatial database cluster method. The proposed method has the cluster log that need to write in fail node case to improve the update transaction. Further research that small mobile devices need to be processed fast in sensor networks is still needed in this area, because a huge amount of data is collected by millions of sensors. Database also should be able to response for any requirement (You et al., 2007).

Relational Database Management System (RDBMS) support for spatio-temporal data is limited and inadequate, most existing spatio-temporal indices cannot be readily integrated into existing RDBMSs. This is one of the problems in the indexing technique for historical Spatio-Temporal point data main subject. The need for Spatio-Temporal Access Methods (STAMs) integrated within a RDBMS has become increasingly apparent. This problem has been solved with proposing a Practical Index for Spatio-Temporal (PIST) data, an indexing technique, rather than a new indexing structure, for historical spatio-temporal data points that can be fully integrated within existing RDBMSs. However, this subject area still has some issues for further research that must increase the number of indexed temporal ranges and hence the number of records in the database (Botea et al., 2007).

Limited memory and a low computational capacity in the mobile devices are some of the problems in the spatial index and hashing technique area. The volume of spatial data and the computational cost of spatial operations are very tremendous, but on the other hand the mobile devices own a limited memory and a low computational capacity than the Personal Computer (PC). Therefore, a spatial index for the mobile devices should be small and achieve good filtering efficiency as well. This problem has been solved using a spatial index called MHF (Multilevel Hashing File) method for the mobile map service. The construction's storage utilization of MHF is using the simple hashing technique to improve the searching performance. Thus designs a compression scheme of MBR (Minimum Bounding Rectangle) called HMBR (Hybrid MBR). Further research that the index is expected to be useful for mobile map service, ITS (Intelligent Transportation System), LBS (Location Based Service) to have been increasingly studied recently is still needed in this area (Kim et al., 2005).

Database is an essential component in GIS and no doubt, a poor access is a burden to the performance. Concentrating on optimizing the database will give better GIS application performance. Since the majority of latest issues and problems come from design database area, focusing on design database area that can be solved using spatial data indexing method is an essential matter. The development of spatial data indexing approach, including tuning spatial data indexing itself for Mobile GIS technology, is one of good steps. Spatial index is very important in GIS because it is used by spatial databases to optimize spatial queries that can fasten transferring process and spatial data retrieval through Mobile GIS network.

R-tree and Quadtree indexes that use extensive framework are the best spatial data indexing methods among any other existing spatial indexing methods for low-dimensional spatial data (Kothuri et al, 2002). For queries processing, R-tree approach may be more efficient due to better maintenance of spatial immediacy, but may be slow in updating or index creating and implementation of own concurrency protocols on top of table-level concurrency mechanisms, since R-tree is built logically as a tree and physically using tables inside the database and search involves recursive SQL for traversing tree from root to relevant leaves. Linear Quad- tree results in simpler index creation, faster update and inherite configuration in B-tree concurrency control protocols, since those indexes compute tile approximations for geometries and use existing Btree indexes for performing spatial search and other DML operations.

Most of previous researchers described above have experimented in changing the structure of R-tree and Quadtree spatial data indexing method that could give better performance. However it still leaves some issues and problems that need to be solved. One of the most common issues and problems is that the method is only applicable to some of applications such as data arrangement, but it needs speed improvement in transfer process and data retrieval. This research gives different methodology that concentrates on fine tuning of a spatial database system using R-tree and Quadtree spatial data indexing method, without changing the structure of those spatial data indexing method. This research proposes QuadR-tree, a selection engine to choose between R-tree and Quadtree spatial data indexing method. Consequently, there are two spatial indexes in a single spatial database system which combines R-tree and Quadtree. Most of common issues and problems above, that each one only optimal in different condition can be solved with this research proposed method. The proposed method read the input condition to be matched with the knowledge in the rule base data set, which is dynamic and can be updated again. Thus, every different map condition and application still can be run with optimum performance if we apply our proposed method.

Previous research (Chen et al, 2003 and Francis et al., 2008) that delivers similar methodology and contributes improvement to this research is Hybrid Quadtree and R-tree spatial data indexing method. QR-tree presenting a quick speed spatial indexing structure based on Quadtree and R-tree. It carries out data space with the space level partition strategy of Quadtree multistage partition and uses different R-tree index space object for each partition subspace. The research indicates that although QR-tree always demands more storage space than R-tree, it gains better performance in insertion, deletion, and especially searching. The result also showed that the more amounts of spatial data, the less cost and the better performance of QR-tree. In the other word, for a very large spatial database, QR-tree possesses more superior than R-tree (Chen et al, 2003). Another similar methodology is a scalable constraint-based Q-hash indexing for moving objects (Francis et al., 2008). These previous researches combine the algorithm structure of R-tree and Quadtree to become a new structure of spatial data indexing method. However these previous researches have some problems that need a big storage, besides it is only better in some ranges of data as well as moving object environment.

To summarize this problem background, firstly it can be seen that the majority latest issues and problems in Mobile GIS come from database area. Mobile GIS needs wireless technology, but a problem comes from system bottleneck. According to Kim and Shi research, the main problem in system bottleneck is because of database side (Kim & Shi, 2002). Database area can be grouped into two branches, i.e database designs and access database. Due to the majority latest issues and problems come from design database, our research tries to focuse on this area, by choosing R-tree and Quadtree spatial data indexing method, since both are the best spatial data indexing method for mobile GIS technology. Secondly, we find the nearest research that delivered similar methodology which brings new improvement for our research.

1.3 Problem Statement

Generally, a problem in Mobile GIS lies in transfer process and spatial data retrieval using wireless technology that is still not efficient. To improve that process, therefore some optimization in spatial database system is a mandatory thing. One of the ways to optimize process of transferring and retrieving data in spatial database system through Mobile GIS network is spatial data indexing approach. The best spatial data indexing methods are R-tree and Quadtree. Each of those methods has different advantages and disadvantages based on the requirement of the applications and type of data; if Quadtree and R-tree are used together for data indexing in a single spatial database system, the database can be optimized with the appropriate spatial data indexing method and contribute to improve spatial data transferring speed. Currently, there is no selection algorithm to select between those of spatial data indexing methods.

1.4 Goal and Objectives

The goal of this research is to provide new method of tuning spatial database for improve speed of data manipulation by developing selection engine. The objectives in order to realize this goal are:

i. To define parameter of spatial data optimization based on Quad-tree and R-tree for tuning method.
ii. To design selection algorithm using rule based expert knowledge for develop selection engine of tuning method.
iii. To develop selection engine for spatial data optimization in GIS application to validate and testing the proposed approach.

1.5 Scope of the Study

The scope of the research includes:

i. The first scope is defining the selection parameter. It needs to understand the requirement of applications and type of data. The selecting parameter is based on the advantages and disadvantages of R-tree and Quadtree spatial data indexes, in regards of this research only proposed the combination of using those spatial data indices.
ii. The second scope is developing selection engine. It needs to understand some of the selection algorithms for selecting only two objects. The selection algorithm is based on the knowledge of R-tree and Quadtree spatial data indexes, which means it only needs to explore based on the ruled based selection method in the knowledge dataset.
iii. The third scope is developing prototype of Mobile GIS application for testing and validation. It needs to understand the applications that can be run effectively in Mobile GIS application. Web based application can be run in any mobile applications using browser without require specific program.

1.6 Expected Contribution and Summary

This research is expected to provide new paradigm in combining the used of more than one spatial data indexes without changing the structure of those spatial data indexes. This research is also expected to propose selection algorithm in R-tree – Quadtree spatial data indexes and Mobile GIS area using Rule Based Knowledge Expert. This chapter starts from introduction, problem background and problem statement in Mobile GIS and spatial data indexes algorithm, specifically R-tree and

Quadtree spatial data indexes. The goals and objectives with the limitation of scope covered under this research have also been described. Finally, this research ends with expected contribution and summary.

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